TECHNICAL REPORT

Contract Title:	Infrared Algorithm Development for Ocean Observations with EOS/MODIS
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Principal Investigator:	Otis B. Brown RSMAS/MPO University of Miami 4600 Rickenbacker Causeway Miami, Florida 33149-1098

INFRARED ALGORITHM DEVELOPMENT FOR OCEAN OBSERVATIONS WITH EOS/MODIS

Abstract

Efforts continue under this contract to develop algorithms for the computation of sea surface temperature (SST) from MODIS infrared retrievals. This effort includes radiative transfer modeling, comparison of *in situ* and satellite observations, development and evaluation of processing and networking methodologies for algorithm computation and data accession, evaluation of surface validation approaches for IR radiances, and participation in MODIS (project) related activities. Efforts in this contract period have focused on radiative transfer modeling, evaluation of atmospheric correction methodologies, involvement in field studies, production and evaluation of new computer networking strategies, and objective analysis approaches.

MODIS INFRARED ALGORITHM DEVELOPMENT

A. Near Term Objectives

A.1. Continue algorithmic development efforts based on experimental match-up databases and radiative transfer models.

A.2. Continue interaction with the MODIS Instrument Team through meetings and electronic communications.

A.3 Continue evaluation of different approaches for global SST data assimilation and work on statistically based objective analysis approaches.

A.4 Continue evaluation of high-speed network interconnection technologies.

A.5 Continue evaluation of various *in situ* validation instruments for the MODIS IR bands.

A.6 Provide investigator and staff support for the preceding items.

B. Overview of Current Progress

B.1 January-March 1996

Activities during the past three months have continued on the previously initiated tasks with no initiation of new tasks. There have been specific continuing efforts in the areas of (a) radiative transfer modeling, (b) generation of model based retrieval algorithms, (c) continued work on IR calibration/validation as part of the MODIS Ocean Science Team cruise effort, (d) involvement in a DOE/ARM atmospheric characterization cruise, and (e) work on test and evaluation of an experimental wide area network based on ATM technology. Previously initiated activities such as team related activities are ongoing.

B.1.1 Radiative Transfer Modeling

Simulations were done to study methods of splitting the various parameter spaces to improve retrieval equation accuracy. The RAL radiation transfer code has been rewritten to extend its spectral coverage to include the MODIS infrared channels, to improve its performance on Alpha machines (DEC/UNIX), and to permit it to provide profiles of channel radiance through the atmosphere.

In the first quarter of 1996, Richard Sikorski focused on testing and updating a VMS version of the RAL model, starting from a version originally supplied by the Rutherford Appleton Laboratory.

We have also located additional sources of atmospheric data that can be used with the RAL model, including:

1) The NASA/Goddard Distributed Active Archive Center, *e.g.*, Assimilated 4-D Climate Data, Earth Science data sets, *i.e.*, TOGA/Coare Data, Interdisciplinary Data Collection, *i.e.*, NOAA/NASA, and, Pathfinder/TOVS.

2) The NASA/Goddard Data Assimilation Office, *e.g.*, GEOS-1 Multiyear Assimilation, Upper Atmosphere Research Satellite (UARS) data set, and, TOGA COARE assimilations.

3) The NASA/Langley Distributed Active Archive Center, including Liquid Water (lwp), the Cloud Liquid Water (lwpcld), and, Water Vapor (pwc) data sets.

4) The NASA/Marshall Distributed Active Archive Center, including the NASA Water Vapor Project (NVAP) data set.

5) The NCAR Atmospheric Technology Division Research Data Program, *e.g.*, the Tropical Ocean/Global Atmosphere (TOGA-COARE) data set.

6) The NOAA Forecast Systems Laboratory (FSL) National RAOB database.

7) The TIGR Radiosonde database.

8) The University of Colorado, *e.g.*, the Arctic Water Vapor Characteristics, and, the TOVS Pathfinder Path-P Arctic Atmospheric data sets.

B.1.2 Algorithm Development Efforts Based on Experimental Match-up Data bases

The main objective of our recent work is to explore the associations between atmospheric water vapor content and various AVHRR-derived quantities. Work by Dr. A. Mariano is exploring compact representations of atmospheric correction equations based on principal components analyses.

An extended global marine radiosonde data base is being compiled for use with this model to simulate MODIS brightness temperature measurements.

B.1.3 Wide Area Networking

Efforts to test an experimental high speed network between the FORE and DIGITAL ATM switches at the University of Miami have continued. A "beta" test ATM interface for the SGI/Challenge was installed and is interoperating well with the Digital and FORE hubs - the SGI machine is being used as a file server for retrospective AVHRR SST processing. All retrospective processing has been ported to the ATM network, *i.e.*, archival access, computing and intermediate storage are now accessible via the ATM network. This configuration is carrying the order of 40 Gigabytes of traffic per day.

B.1.4 *In Situ* Calibration/Validation of MODIS IR Radiances

Building the success of the proof-of-concept cruise in the Gulf of Mexico in January 1995 in which the AERI (Atmospheric Emitted Radiance Interferometer) was shown to be sufficiently robust to work at sea and sufficiently accurate to be used to validate MODIS measurements (Smith *et al*., 1996), cruise participation was arranged to test the prolonged use of the AERI in a harsh marine environment. As part of the NOAA/DOE "Combined Sensor Cruise" to the Tropical Western Pacific, a group from the University of Wisconsin, Madison accompanied Dr. Peter Minnett with a prototype Marine-AERI on the NOAA ship *Discoverer.* The cruise dates were March 17 (leaving U.S. Samoa) to April 13 (arriving Pearl Harbor, Hawaii), and the ancillary equipment on the *Discoverer* provided an unprecedented data set for studying the performance of the AERI and the effects of atmospheric and oceanic variability on satellite measurements. The cruise is in a climitological extreme for surface temperature and atmospheric water vapor loading.

Initial results from the cruise are very promising. The AERI and ancillary equipment worked well, and there are strong signals in the data from the oceanic thermal-skin effect and from diurnal heating cycles in the upper ocean. Observed maximum diurnal differences between bulk and skin temperatures approached 2K with surface temperatures in excess of 300K.

A validation plan was submitted to the MODIS Project for infrared radiances (MODIS - Infrared Sea Surface Temperature Algorithm Science Data Validation Plan, O. Brown/P. Minnett. Submitted to NASA/GSFC, January 1996)**.** The strategy includes a combination of drifting buoy, cruise and fixed (time series) observations. It must be noted that this plan can only be carried out if the current out year support profile for this contract is sustained.

This document sets out the validation strategy for the MODIS infrared channels that are to be used in the derivation of SST. It proposes a multi-pronged approach using a variety of instruments and techniques that will provide quantitative bases for confidence in both the in-flight calibration procedure and the correction for atmospheric effects in the SST determination.

This document will be revised at appropriate intervals to take into account new findings in this field, and to document new collaborative opportunities that may be relevant to the MODIS AM-1 infrared validation exercise.

C. Investigator Support

January N/A

February N/A

March V. Halliwell

D. Future Activities

D.1 Current:

D.1.1 Algorithms

a. Continue to develop and test algorithms on global retrievals
b. Evaluation of global data assimilation statistics for SST fields
c. Continue RT modeling using RAL code
d. ATBD updates (as needed)
e. Define and implement an extended ATM based network test bed
f. Evaluate and analyze results of calibration/validation experiment
g. Continued integration of new workstations into algorithm development environment

D.1.2 Investigator support

Continue current efforts.

E. Problems

No new problems to report.

F. Publications

Smith, William L., R.O. Knuteson, H.E. Revercomb, W. Feltz, H.B. Howell, W.P. Menzel, N. Nalli, O.B. Brown, J. Brown, P. Minnett and W. McKeown. Observations of the Infrared Radiative Properties of the Ocean-Implications for the Measurement of Sea Surface Temperature via Satellite Remote Sensing. *Bull. Amer. Meteor. Soc.*, **77 (1)**, 1996, 41-51.

G. References:

None.